

CLAIMS

5 1.- A ground-plane for an antenna device characterized in that said ground-plane includes at least two conducting surfaces, said two conducting surfaces being connected by at least a conducting strip which allows current to flow from one conductive surface to another, said strip being narrower than the width of any of said two conducting surfaces.

10 2.- A ground-plane for an antenna device according to claim 1, wherein said conducting surfaces are laying over a common planar or curved surface.

15 3.- A ground-plane for an antenna device according to claim 1 or 2, wherein two edges of at least two conducting surfaces are placed substantially parallel to each other, and said at least strip connecting said two surfaces is placed substantially centered with respect to the gap defined by said two substantially parallel edges.

20 4.- A ground-plane for an antenna device according to claim 1, 2, or 3, wherein the ground-plane includes at least three conducting surfaces, in which one pair of any of two adjacent conducting surfaces are connected by means of at least a conducting strip, and the rest of pairs of adjacent conducting surfaces are electromagnetically connected by means of a capacitive effect or by direct contact provided by at least a conducting strip.

25 5.- A ground-plane for an antenna device according to claim 4, wherein said strips are substantially aligned along a straight axis.

6.- A ground-plane for an antenna device according to claim 4, wherein said strips are not aligned along a straight axis.

7.- A ground-plane for an antenna device according to claim 1, 2, or 4, wherein it includes at least two conducting strips, both strips connecting at least two of said conducting surfaces at least at two points located at both edges of said conducting surfaces.

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8.- A ground-plane for an antenna device according to claim 1, 2, 4, 6, or 7, wherein at least one of said strips is aligned along one of the edges defining the external perimeter of said ground-plane.

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9.- A ground-plane for an antenna device according to claim 2, said ground-plane comprising a plurality of conducting surfaces laying on the same planar or curved surface, wherein at least two of said conducting surfaces are connected by means of a conducting strip.

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10.- A ground-plane for an antenna device according to claim 1, 2, 3, 4, 5, 6, 7, 8, or 9, wherein each couple of adjacent conducting surfaces are connected by means of at least a conducting strip.

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11.- A ground-plane for antenna device according to claim 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10, wherein all the conducting surfaces defining said ground-plane have a substantially rectangular shape, said rectangular shapes being sequentially aligned along a straight axis, each pair of rectangular shapes defining a gap between them, at least a couple of opposite edges of at least one of said gaps being connected by at least a conducting strip.

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12.- A ground-plane for an antenna device according to claim 1, 2, 4, 6, 8, 9, 10, or 11 wherein all the conducting surfaces defining said ground-plane have the same horizontal width and are sequentially aligned along a straight vertical axis, wherein each pair of adjacent conducting surfaces define a gap between them, wherein each pair of adjacent conducting surfaces are connected across said gap by means of a conducting strip, said strip being aligned along an edge

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of the external perimeter of said ground-plane, said edge being alternatively and sequentially chosen at the right and left sides with respect of a vertical axis crossing the center of the ground-plane.

- 5        13.- A ground-plane for an antenna device according to claim 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, or 12, wherein at least one of the strips connecting two of said conducting surfaces is shaped as a zigzag or meandering curve.
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- 15      15.- A ground-plane for an antenna device according to claim 14, wherein said segments intersect to each other at the tips of the curve.
- 20      16.- A ground-plane for an antenna device according to claim 14 or 15 wherein the corners formed by each pair of said adjacent segments are rounded or smoothed otherwise.
- 25      17.- A ground-plane for an antenna device according to any of the claims 14 to 16 wherein the curve is periodic along a fixed straight direction of space if, and only if, the period is defined by a non-periodic curve composed by at least ten connected segments and no pair of said adjacent and connected segments define a straight longer segment.

18.- A ground-plane for an antenna device according to claim 14, wherein at least one of its parts is shaped as a SFC, wherein said SFC features a box-counting dimension larger than one, being said box-counting dimension computed as usual as the slope of the straight portion of a log-log graph, wherein such a straight portion is substantially defined as a straight segment over at least an octave of scales on the horizontal axis of the log-log graph.

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19- A ground-plane for an antenna device according to any of the claims 14 to 18, wherein at least one of its parts is shaped either as a Hilbert, Peano, SZ, ZZ, HilbertZZ, Peanoinc, Peanodec, or PeanoZZ curve.

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20.- A ground-plane for an antenna device according to any of the claims 14 to 19, wherein at least one of the strips connecting two of said conducting surfaces is shaped as an SFC.

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21.- A ground-plane for an antenna device according to any of the claims 1 to 20 wherein at least one of the gaps between at least two of said conducting surfaces includes at least two conducting strips of different length.

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22.- A ground-plane for an antenna device according to any of the claims 14 to 20 wherein at least a portion of the gap between at least two of said conducting surfaces defining the ground-plane is shaped as an SFC.

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23.- A ground-plane for an antenna device according to any of the claims 14 to 22 wherein at least 50% of surface covered by said ground-plane is filled out by means of a strip, said strip being shaped as an SFC.

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24.- A ground-plane for an antenna device according to any of the claims 1 to 23 wherein at least a portion of the geometry of said ground-plane is a multilevel structure, said multilevel structure including a set of conducting polygons, all of said polygons featuring the same number of sides, wherein said

polygons are electromagnetically coupled either by means of a capacitive coupling or ohmic contact, wherein the contact region between directly connected polygons is narrower than 50% of the perimeter of said polygons in at least 75% of said polygons defining said conducting ground-plane.

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25.- A ground-plane for antenna device according to any of the claims 1 to 24, wherein the shape of the perimeter of said ground-plane, the shape of the conducting surfaces, or both kinds of elements included in said ground-plane are square, rectangular, triangular, circular, semi-circular, elliptical, or semi-elliptical.

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26.- A ground-plane for an antenna device according to the preceding claims, wherein the antenna device is a handheld wireless device.

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27.- A ground-plane for an antenna device according to any of the claims 1 to 25, wherein the antenna device is a microstrip patch antenna.

28.- A ground-plane for an antenna device according to any of the claims 1 to 25, wherein the antenna device is a Planar Inverted-F Antenna (PIFA).

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29.- A ground-plane for an antenna device according to any of the claims 1 to 25, wherein the antenna device is a monopole antenna.

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30.- An antenna device including a ground-plane according to any of the preceding claims, wherein the antenna is smaller than a half of the free-space operating wavelength.

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31.- An antenna device according to any of the claims 1 through 30, wherein the antenna is smaller compared to another antenna with the same radiating element but with a conventional solid ground-plane.

32.- An antenna device according to any of the claims 1 through 31, wherein the antenna features a broader bandwidth with respect to another antenna with the same radiating element but with a conventional solid ground-plane of the same size and external perimeter shape.

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33.- An antenna device according to any of the claims 1 through 32, wherein the antenna features a multiband behavior.

10 34.- An antenna device according to claims 24, 25, 26, 27, 28, or 29, wherein the antenna is used to provide coverage in micro-cells or pico-cells at least one of the cellular systems AMPS, GSM900, GSM1800, PCS1900, UMTS, CDMA, or at least a WLAN system such as IEEE 802.11, Bluetooth, or a combination of them.

15 35.- An antenna device according to any of the claims 27 to 32 wherein the antenna is mounted inside the rear-view mirror of a motor vehicle to provide coverage to at least one of the cellular systems AMPS, GSM900, GSM1800, PCS1900, UMTS, CDMA, or at least a WLAN system such as IEEE802.11, Bluetooth, or a combination of them.

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36.- An antenna device according to any of the claims 27 to 32 wherein the antenna is mounted inside the keyless door lock operation device.

25 37.- An antenna device according to claims 1 through 25 characterized in that the radiating element has substantially the same shape as the ground-plane, said radiating element being placed parallel or orthogonal to said ground-plane.